Use of Computer Based Training for Aircraft Inspectors: Findings and Recommendations

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ABSTRACT

Research in aircraft inspection and maintenance has revealed the criticality of human inspection performance in improving aviation safety. Training has been identified as the primary intervention strategy in improving the quality and reliability of aircraft inspection performance. If training is to be successful, it is clear that we need to provide aircraft inspectors with tools to help enhance their inspection skills and improve performance. In response to this need, the Clemson research team developed a high fidelity inspection-training simulator (ASSIST: Automated System of Self Instruction for Specialized Training) – a specialized inspection software focused on improving aircraft inspection performance. Following the development a detailed usability evaluation was conducted and is reported as a part of this paper.

INTRODUCTION

Training has been identified as the primary intervention strategy in improving inspection performance. If training is to be successful, it is clear that we need to provide inspectors with training tools to help enhance their inspection skills. Existing training for inspectors in the aircraft maintenance environment tends to be mostly on-the-job training (OJT). Nevertheless, this may not be the best method of instruction (FAA, 1991; Gordon, 1994). For example, in OJT feedback may be infrequent, unmethodical, and/or delayed. Moreover, in certain instances feedback is economically prohibitive or infeasible due to the nature of the task. Thus, because the benefits of feedback in training have been well documented (e.g. Weiner, 1975), and for other reasons as well, alternatives to OJT are sought.

In response to this need, this paper describes the findings of implementing a computer based inspection training system, entitled ASSIST (Automated System of Self Instruction for Specialized Training), for aircraft inspection training. Specifically the paper describes the results of usability studies that focused on evaluating ASSIST in the aircraft maintenance environment. Thus, off-line training/retraining with feedback has a role to play in aircraft inspection training.

ASSIST SYSTEM DESCRIPTION

ASSIST consists of three major modules: (1) General Inspection module, (2) Inspection Simulation Training module, and (3) Instructor's Utilities module. All system users interact through a user-friendly interface. The user interface capitalizes on graphical user interface technologies and human

factors research on information presentation (e.g. color, formatting, layout, etc.), ease of use and information utilization.

ASSIST System Specification

The ASSIST program runs on at least a Pentium 100, with a 166 Pentium or greater suggested. A minimum hard drive space of 220 MB is required with at least 24 MB of memory, while 64 MB is the suggested memory. ASSIST runs on a Windows 95, or higher, operating system. The program also requires a SoundBlaster compatible sound card and 8X CD-ROM. The display requirements are 640 X 480 resolution with a high color (16 bit) palette. The program uses text, graphics and audio. The system's input devices are a keyboard and a mouse.

General Module

The objective of the general module is to provide the inspectors with an overview on the following topics: (1) role of the inspector, (2) safety, (3) aircraft review, (4) factors affecting inspection, and (5) inspection procedure. Each of these topics was made into a sub-module in the General Module. The module is based on presenting information through various media of text, pictures, audio, and video. At the end of each sub-module is a three-question quiz to reinforce the information learned. Development of the General Module was an iterative process involving regular feedback from industry partners on the content of each sub-module.

Instructor's Utilities Module

This module allows the instructor to access the results of the final test in the general module and the simulator along with having a utility to setup parameters for a simulation (Figure 12). The module is designed as a separate stand-alone tool that is linked to the other modules of the system. The instructor's module allows the instructors to review the performance of a trainee who has taken several training and/or testing sessions. Performance data from the simulator is stored on an individual image basis and summarized over the entire session so that results can be retrieved at either level. The utility allows the instructor to print or save the results to a file. The objective of this functionality is to provide the instructor with a utility where a specific image along with its associated information can be viewed on the computer screen.

Inspection Simulation Training Module

This module of the training program provides inspection training on a simulated aircraft inspection task (Aft Cargo Bin inspection of a Lockheed Martin L-1011. By manipulating the various task complexity factors (shape of viewing area, spatial distribution of faults, fault probability, fault mix, fault conspicuity, product complexity, and fault standards) the instructor can simulate different inspection scenarios. The simulation module uses actual photographs of the airframe structure with computer-generated defects.

FINDINGS AND RECOMMENDATIONS

Usability Analysis Results

To test whether the ASSIST software met usability goals, inspectors, supervisors, and mechanics at aircraft maintenance facilities evaluated the software on specific usability dimensions (e.g., content, presentation, and format). A separate usability questionnaire was administered for the general and the simulation modules. The questionnaire for the General Module and the Simulation Module are shown in Figures 1-6. Similar questions where asked about the Simulation Module.

The Cronbach's Alpha Coefficient was calculated for content, presentation, and format. These results are shown in Table 1. The coefficients for each category of questions were within the prescribed limits (0.6 and 1.0) therefore it was appropriate to group the questions together in to their respective dimension. The preliminary results of the usability survey are summarized in Table 2, listing the mean and standard deviation for each usability dimension. A Wilcoxon signed rank test was used to compare whether the subjects preferred the system of each of the three different usability dimensions. The test compared the actual mean scores versus the expected mean score (of 4.0). The results revealed that the subjects favored the computer system on all the dimensions investigated (refer to Table 3).

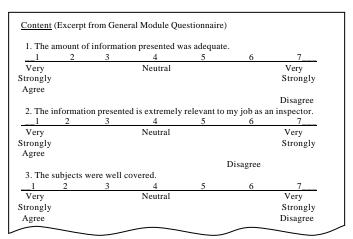


Figure 1: Content Section from General Module

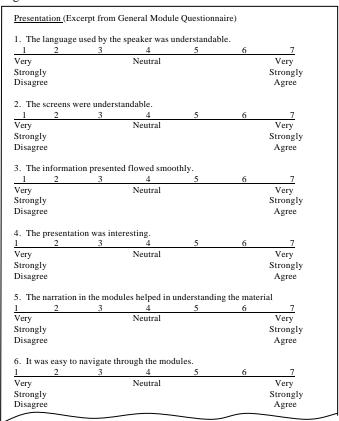


Figure 2: Presentation Section from General Module

1. The colors u	sed on the sci	een did not di	stract from t	he task or	cause eye
discomfort.					
1 2	3	4	5	6	7
Very		Neutral			Very
Strongly					Strongly
Disagree					Agree
2. The buttons	on the screen	were easy to t	ınderstand.		
1 2	3	4	5	6	7
Very		Neutral			Very
Strongly					Strongly
Disagree					Agree

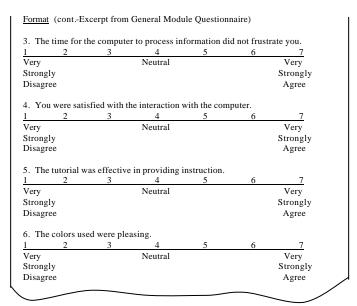


Figure 3: Format Section from General Module

		n presented wa	s adequate.		
1 2	3	4	5	6	7
Very		Neutral			Very
Strongly					Strongly
Disagree					Agree
2. The subjects	were thoroug	hly covered.			
1 2	3	4	5	6	7
Very		Neutral			Very
Strongly					Strongly
Disagree					Agree
B. The informat	tion presente	d was understa	ndable.		
1 2	3	4	5	6	7
		Neutral	<u> </u>		Very
Very					
Very Strongly		redirar			Strongly

Figure 4: Content Section from Simulation Module

	Neutral			Very
				Strongly
				Agree
re unders	tandable.			
3	4	5	6	7
	Neutral			Very
				Strongly
				Agree
n present		thly.		
3		5	6	7
	Neutral			Very
				Strongl
				Agree
the mod	lules helped in u	nderstandii	ng the mate	erial.
			-	
3	4	5	6	7
	4 Neutral	5	6	Very
	3 n presente	Neutral n presented flowed smoo	3 4 5 Neutral presented flowed smoothly. 3 4 5	3 4 5 6 Neutral presented flowed smoothly. 3 4 5 6

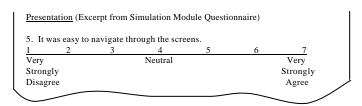


Figure 5: Presentation Section from Simulation Module

 The colors us 	sea on the so	reen ala not als			
discomfort.					· _
12	3	4	5	6	
Very		Neutral			Very
Strongly					Strongly
Disagree					Agree
2. The buttons	on the scree	n were easy to u	ınderstand.		
		4	5	6	7
Very		Neutral			Very
strongly					Strongly
Agree					Disagree
3. The time for					
	3	4 Neutral	5	6	7
Very		Neutral			Very
Strongly					Strongly
Disagree					Agree
_1 2 Very		the interaction v 4 Neutral	vith the composition 5	uter. 6	7Very
4. You were sat 1 2 Very Strongly Disagree		4			7Very Strongly Agree
1 2 Very Strongly Disagree	3	4 Neutral	5		Strongly
1 2 Very Strongly	3 was effectiv	4 Neutral	5		Strongly
1 2 Very Strongly Disagree 5. The tutorial v	3 was effectiv	4 Neutral	5 nstruction.	6	Strongly
1 2 Very Strongly Disagree 5. The tutorial 1 2	3 was effectiv	4 Neutral e in providing in 4	5 nstruction.	6	Strongly Agree
1 2 Very Strongly Disagree 5. The tutorial v 1 2 Very	3 was effectiv	4 Neutral e in providing in 4	5 nstruction.	6	Strongly Agree 7 Very
1 2 Very Strongly Disagree 5. The tutorial 1 2 Very Strongly Disagree	3 was effectiv 3	4 Neutral e in providing in 4 Neutral	5nstruction.	6	Strongly Agree 7 Very Strongly
1 2 Very Strongly Disagree 5. The tutorial 1 1 2 Very Strongly Disagree 6. The picture q	was effectiv 3	4 Neutral e in providing in 4 Neutral for the aircraft v	nstruction. 5	6	Strongly Agree 7 Very Strongly
1 2 Very Strongly Disagree 5. The tutorial 1 2 Very Strongly Disagree 6. The picture of 1 2	was effectiv 3	4 Neutral e in providing in 4 Neutral for the aircraft v	5nstruction.	6	Strongly Agree 7 Very Strongly Agree
1 2 Very Strongly Disagree 5. The tutorial 1 2 Very Strongly Disagree 6. The picture of 1 2 Very	was effectiv 3	4 Neutral e in providing in 4 Neutral for the aircraft v	nstruction. 5	6	Strongly Agree 7 Very Strongly Agree 7 Very
1 2 Very Strongly Disagree 5. The tutorial v 1 2 Very Strongly Disagree 6. The picture of 1 2 Very Strongly	was effectiv 3	4 Neutral e in providing in 4 Neutral for the aircraft v	nstruction. 5	6	Strongly Agree 7 Very Strongly Agree 7 Very Strongly Strongly
1 2 Very Strongly Disagree 5. The tutorial 1 2 Very Strongly Disagree 6. The picture of 1 2 Very	was effectiv 3	4 Neutral e in providing in 4 Neutral for the aircraft v	nstruction. 5	6	Strongly Agree 7 Very Strongly Agree 7 Very
1 2 Very Strongly Disagree 5. The tutorial v 1 2 Very Strongly Disagree 6. The picture of 1 2 Very Strongly	was effectiv 3 quality used 3	4 Neutral e in providing in 4 Neutral for the aircraft v 4 Neutral	nstruction. 5 was realistic. 5	6	Strongly Agree 7 Very Strongly Agree 7 Very Strongly Strongly
1 2 Very Strongly Disagree 5. The tutorial v 1 2 Very Strongly Disagree 6. The picture of 1 2 Very Strongly Disagree 7. The picture of 1 2 1 2	was effectiv 3 quality used 3	e in providing in 4 Neutral for the aircraft v 4 Neutral e defects was rea	nstruction. 5 was realistic. 5	6	Strongly Agree 7 Very Strongly Agree 7 Very Strongly Agree
1 2 Very Strongly Disagree 5. The tutorial value of the picture o	was effectiv 3 quality used 3	e in providing in A Neutral for the aircraft v 4 Neutral	nstruction. 5 was realistic. 5	6	Strongly Agree 7 Very Strongly Agree 7 Very Strongly Strongly
1 2 Very Strongly Disagree 5. The tutorial v 1 2 Very Strongly Disagree 6. The picture of 1 2 Very Strongly Disagree 7. The picture of 1 2 1 2	was effectiv 3 quality used 3	e in providing in 4 Neutral for the aircraft v 4 Neutral e defects was rea	nstruction. 5 was realistic. 5	6	Strongly Agree 7 Very Strongly Agree 7 Very Strongly Agree

Figure 6: Format Section from Simulation Module

Usability	Cronbach Alp	ha Coefficient
Dimension	General Module	Simulation Module
Content	0.94	0.82
Presentation	0.82	0.63
Format	0.68	0.73

Table 1: Results from Cronbach Analysis

Usability Dimension	7 point ra 1	ting scale 7	General Module Mean (S.D.)	Simulation Module Mean (S.D.)
Content	Very	Very	5 15 (1 5)	47(14)
Content	Strongly Disagree	Strongly Agree	5.15 (1.5)	4.7 (1.4)
	Very	Very		
Presentation	Strongly	Strongly	5.4 (0.98)	5.1 (1.4)
	Disagree	Agree		
	Very	Very		
Format	Strongly	Strongly	5.2 (1.2)	5.0 (1.5)
	Disagree	Agree		

Table 2: Results from the Usability Questionnaire

Issue Addressed	Wilcoxon Result	Indications
Content	p < 0.05	$\mu = 4$ (Significantly)
Presentation	p < 0.05	$\mu = 4$ (Significantly)
Format	p < 0.05	$\mu = 4$ (Significantly)

Table 3: Results from Wilcoxon Signed Rank Test

Recommendations

Control studies are currently underway which will evaluate the usefulness of the ASSIST Program in improving inspection performance. Initial results of these studies have been encouraging. It is anticipated that the use of ASSIST will standardize inspection training leading to improved inspection performance, ultimately yielding improved aircraft safety and reliability.

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